Please add new Claim 19 as shown below.

19. (New) The processor according to claim 14, wherein the two kinds of light have frequencies resonant with the optically allowed transitions other than transitions coupled through a common resonator mode of selected two physical systems.

REMARKS

Favorable reconsideration of this application, as presently amended and in light of the following discussion, is respectfully requested.

Claims 1-19 are presently active. Claims 6 and 14 have been amended; and Claim 19 has been added by the present amendment. The changes and additions to the claims are supported by the originally filed specification and do not add new matter.

In the outstanding Office Action, Claims 1-5, 11-14, and 16-18 were rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 3,754,988 to Barnes (hereinafter "the '988 patent") in view of U.S. Patent No. 6,298,180 to Ho (hereinafter "the '180 patent") and Vitanov et al. ("Properties of stimulated Raman adiabatic passage with intermediate-level detuning") (hereinafter "Vitanov"); Claims 6, 7, 9, and 10 were rejected under 35 U.S.C. § 103(a) as being unpatentable over the '988 patent, the '180 patent, and Vitanov, further in view of Cirac et al. ("Quantum Computations with Cold Trapped Ions") (hereinafter "Cirac")[2]; and Claims 8 and 15 were rejected under 35 U.S.C. § 103(a) as being unpatentable over the '988 patent, the '180 patent, and Vitanov, further in view of U.S. Patent No. 5,371,388 to Oda (hereinafter "the '388 patent").

Claim 1 is directed to a method for quantum information processing, comprising, *inter alia*: (1) providing physical systems arranged in a resonator, each physical system having

[2] However, the Examiner stated in a telephone discussion on April 24, 2003, that Claims 11-13 should have been rejected on the same grounds as Claim 10, from which Claims 11-13 depend. Applicants will address the rejection of Claims 11-13 accordingly.

three energy levels, two of three transitions between the three levels being optically allowed, and wherein at least two physical systems are included, one transition of the optically allowed two transitions being different in transition frequency for respective physical systems, and the at least two physical systems being coupled quantum-mechanically through a common resonator mode; (2) irradiating one physical system selectively with two kinds of light; (3) irradiating another physical system selectively with two kinds of light; and (4) irradiating the two physical systems simultaneously with two kinds of light, the two kinds of light having frequencies resonant with the optically allowed transitions other than the transitions coupled through the common resonator mode, thereby exchanging the quantum states between the two physical systems.

Regarding the rejection of Claim 1, the Office Action asserts that the '988 patent discloses everything in Claim 1 with the exception of "three energy levels with an initial state, a resonator around the system as an acousto-optic device to control frequency, and an electro-optic device to generate a light pulse train,"[3] and relies on the '180 patent and the Vitanov reference to remedy the deficiencies. Specifically, the Office Action states that the '180 patent discloses a "resonator around the system...as an acousto-optic device to control frequency and an electro-optic device to generate a light pulse train," and that the Vitanov reference teaches the three energy levels with an initial state.

The '988 patent is directed to a quantum state memory that uses combinations of interactions between light and two energy levels of physical systems to perform quantum switching. Initially, Applicants note that the '988 patent fails to disclose the use of coherent interactions between two kinds of light and three energy levels of physical systems to perform quantum information processing. Moreover, Applicants note that although the memory array disclosed by the '988 patent uses quantum states, the '988 memory is adapted

[3] January 30, 2003, Office Action, page 2.

to process classical information and is not directed to processing quantum information. Moreover, the '988 patent fails to disclose that at least two physical systems are arranged in a resonator and quantum-mechanically coupled through a common resonator mode. Rather, the '988 system discloses physical systems serving as memory cells arranged at the intersections of glass fibers, thereby spatially discriminating the memory cells.

Turning now to the secondary references, the '180 patent is directed to a photon transistor used as a switching device. Moreover, the resonator disclosed by the '180 patent is used as a dichronic filter or coupler. Thus, Applicants submit that the '180 patent is unrelated to quantum information processing. Moreover, the '180 patent fails to disclose at least two physical systems arranged in a resonator and quantum-mechanically coupled through a common resonator mode, as recited in Claim 1.

The Vitanov reference is directed to a method of changing the quantum states of a *single* three-level system. However, the Vitanov reference fails to disclose at least two physical systems arranged in a resonator and quantum-mechanically coupled through a common resonator mode, or that the quantum states of two physical systems are exchanged selectively based on light frequencies, as recited in Claim 1.

Thus, no matter how the teachings of the '988 patent, '180 patent, and Vitanov reference are combined, the combination does not teach or suggest at least two physical systems arranged in a resonator and quantum-mechanically coupled through a common resonator mode, or the process of performing an exchange of quantum states, as recited in Claim 1. Accordingly, Applicants respectfully submit that a *prima facie* case of obviousness has not been established and that the rejection of Claim 1 (and dependent Claims 2-5) should be withdrawn.

In the outstanding Office Action, the stated motivation for combining the '988 patent, '180 patent, and Vitanov reference is that "one would be motivated to use the resonator to

have selectivity in the frequency control for the two kinds of light as implied by Ho" and "since one would be motivated to use these energy levels in adiabatic passage for selective and efficient population transfer of information as implied from Vitanov et al."[4] However, Applicants submit that the Office Action is simply stating perceived advantages of Applicants' invention as motivation to combine the cited references, without identifying that, absent Applicants' specification, one of ordinary skill in the art would have even thought to address the problem. Such hindsight reconstruction of Applicants' invention cannot be used to establish a *prima facie* case of obviousness. Moreover, Applicants note that the '988 patent discloses the use of only *two* energy levels while the Vitanov reference discloses a single *three-level* system. Accordingly, it is unclear to Applicants why one of ordinary skill in the art would have been motivated to combine the '988 and Vitanov systems in the manner suggested in the Office Action. Accordingly, for this additional reason, Applicants respectfully submit that a *prima facie* case of obviousness has not been established and that the rejection of Claim 1 (and dependent Claims 2-5) should be withdrawn.

Amended Claim 14 recites limitations analogous to the limitations recited in Claim 1. Accordingly, for the reasons stated above for the patentability of Claim 1, Applicants respectfully submit that a *prima facie* case of obviousness has not been established and that the rejection of Claim 14 (and dependent Claims 16-18) should be withdrawn.

Regarding the rejection of Claims 6-13 and 15 under 35 U.S.C. § 103(a), Applicants respectfully submit that the '388 patent and the Cirac reference fail to remedy the deficiencies of the '988 patent, '180 patent, and Vitanov references, as discussed above. Accordingly, Applicants respectfully submit that a *prima facie* case of obviousness has not been established and that the rejection of dependent Claims 6-13 and 15 should be withdrawn.

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[4] January 30, 2003, Office Action, page 3.

The present amendment also sets forth new Claim 19, which depends from Claim 14, for examination on the merits. Claim 14 is supported by the originally filed specification and does not add new matter. Moreover, based on its dependence from Claim 14, Applicants submit that new Claim 19 patentably defines over the cited references.

Thus, it is respectfully submitted that independent Claim 1 (and dependent Claims 2-13) and independent Claim 14 (and dependent Claims 15-19) patentably define over the cited references.

Consequently, in view of the present amendment and in light of the above discussion, the outstanding grounds for rejection are believed to have been overcome. The application, as amended herewith, is believe to be in condition for formal allowance. An early and favorable action to that effect is respectfully requested.

Respectfully submitted,

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Marked-Up Copy
Serial No: 09/714,193
Amendment Filed on: 4-30-02

IN THE CLAIMS

--6. (Amended) The method according to claim 1, wherein the states of the three energy levels of each physical system are set to | 0>, | 1>, and | e> in [the] order from [the] a lowest energy level, the | 0>- | e> transition and the | 1>- | e> transition being optically allowed, and wherein a quantum bit is expressed by the state | 0>, the state | 1>, or [their] a superposition state thereof, the method further comprising [comprises]:

in the case where the | 0>- | e> transitions of respective physical systems are coupled through a common resonator mode, irradiating the physical systems with light of a frequency resonant with the | 1>- | e> transitions while scanning the frequency thereof in a range in which transition frequencies of the | 1>- | e> transitions of the physical systems are distributed, thereby effecting preprocessing for information processing; [or] and

in the case where the | 1>- | e> transitions of respective physical systems are coupled through a common resonator mode, irradiating the physical systems with light of a frequency resonant with the | 0>- | e> transitions while scanning the frequency thereof in a range in which transition frequencies of the | [1] 0>- | e> transitions of the physical systems are distributed, thereby effecting preprocessing for information processing.

14. (Amended) A quantum information processor, comprising:

physical systems each having three energy levels, two transitions of three transitions between the three levels being optically allowed, wherein a quantum bit of each physical system is expressed by either of quantum states of two levels [constituting] comprising a

remaining optically forbidden transition or by [their] a superposition state thereof, and wherein at least two physical systems are included, one transition of the optically allowed two transitions being different in transition frequency for respective physical systems, with the other transition of the optically allowed two transitions being common in transition frequency for the respective physical systems;

a resonator provided around the physical systems and having a resonator mode that resonates with the [other] transition common in transition frequency for the respective [of the two transitions of the] physical [system] systems [which are optically allowed]; and

a light source and an optical system configured to irradiate the physical systems with two kinds of light.

19. (New).